A

DISCOURSE

ON THE

CONNEXION BETWEEN

CHEMISTRY AND MEDICINE.

DELIVERED

IN THE UNIVERSITY OF PENNSYLVANIA,

Nov. 5, 1818.

By Thomas Cooper, Esq. M. D.

PROFESSOR OF CHEMISTRY IN THE FACULTY OF ARTS IN THE UNIVERSITY OF PENNSYLVANIA.

' Un ouvrage dans lequel on discute le mode d'action de quelques medicamens d'apres les proprietès que la chimie leur assigne, doit singulierement deplaire a des hommes qui paraissent redouter pardessus tout, de voir le marche de l'experience introduire dans le medicine. On a pu craindre pendant quelque tems que ces partisans d'un aveugle empiricisme et des plus vagues hypotheses, ne nuissent aux progres de la science: mais en dirigeant leur attaques trop haut, ils ont perdu tout credit. Qui ne serait flatté de leur critiques, depuis qu'on les a vus employer les expressions du mepris en parlant de travaux de *Wollaston* at *Berzelius? Review of Dr. Majendie's Treatise on the Gravel, in the Annales de Chimie for April*, 1818, p. 435.

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DEDICATION.

To the Trustees and Professors of the University of New York.

GENTLEMEN,

I DO not submit to your consideration the following discourse, because I suppose the connexion between chemistry and medicine is not duly appreciated and well taught in your University—for, while my excellent friend, Dr. M'Neven, fills the chair of chemistry, all that is necessary to be taught in theory, and illustrated by experiment, in this department of chemical science, will be fully given. But I am anxious to seize the first public opportunity of expressing my obligations for the degree of Doctor in Medicine, which your partiality has been pleased to confer on me; and to assure you, that this public mark of approbation on your part, shall operate as a continual excitement to those exertions by which it has been earned.

Accept, gentlemen, I pray you, my sincere professions of gratitude and respect.

THOMAS COOPER, M. D.

November, 1818.

PREFACE.

DR. RUSH, whose talents, industry, and acquirements, gave him deservedly a very high standing among his fellow citizens, set his face against the utility of classical learning in what he deemed the present improved state of education. Unfortunately, his opinions have had too much weight in this country; and this genuine source of correct taste, and sure foundation of elegant literature, is now undervalued by the parents and the youth of America; who can discover no use in wasting so many years in the acquirement of dead languages, which are forgotten, when the real pursuits of business imperiously lay claim on our time. It is true, Latin and Greek, imperfectly taught and imperfectly learnt, are soon forgotten: it must also be conceded, that these languages aid little in judging of the qualities of merchandise, or in the arrangement of the finance of a compting-house: but it is not easy to see, how a Lawyer or a Physician can occupy a respectable standing without them; nor, how the charms of polished society can be enjoyed, without a reasonable knowledge of the languages, which for so many centuries have formed the passports to literary acquirement, and the subjects of allusion in almost every literary work. In Europe—in England and in Germany particularly, these studies

are considered not merely as the useful, but the indispensible parts of polite education; nor is a knowledge of ancient classic authors in good society there, less common than a knowledge of the most popular publications in the language of the country. Many of our best legal and medical authors—very many of the indispensible books of science—almost all our legal, and medical terms and phrases—the treatises of foreign jurists, the prescriptions of foreign physicians—are comprised in the dead languages: for they have not yet ceased to be the common means of communication in the republic of Letters. These sentiments are universally prevalent among what is usually called good society in Europe; and they are falling into great disrepute in what is called good society in this country.

It would be well, if we confined our neglect to ancient erudition; but the most useful parts of modern science also seem to fall into contempt here, in proportion as they rise in reputation elsewhere.

During the late discussions previous to the election of Dr. Hare to the Chair of Chemistry in the Faculty of Medicine of this University, two opinions appear to have been advanced by the medical faculty :* 1st. That the Chair of Chemistry ought not, or at least need not, be filled by a medical character; because the chair of chemistry was not necessary to, and ought to be separated from, the faculty of medicine. This I know to have been the opinion of Dr. Dorsey, whose premature decease

* With the exception, perhaps, of Dr. Coxe.

we have so much reason to deplore. This gentleman strongly advocated the election of Dr. Hare, against whom the objection was urged, that he had no pretensions whatever to medical knowledge. A second opinion was, that no person but one who had received a medical education, ought to be appointed to the chair of chemistry; because, in his capacity of Professor, he would have to pass upon the merits of candidates for a Degree in Medicine: this was Dr. Chapman's opinion: this gentleman went further; and, considering chemical knowledge rather as an ornamental than an indispensible, or even useful part of medical education, he thought the chair of chemistry ought to be separated from the medical faculty; and that the students should be exonerated from the *necessity* of attending to this branch of knowledge, when they had so many other branches to attend to, which were absolutely indispensible. This appears to have been the general sentiments of the medical faculty of the University of Pennsylvania; for having applied to Dr. Hare, they persuaded him to relinquish his privilege and his duty, of passing upon the qualifications of the medical students when they came forward to be examined for a degree, and of signing their diplomas; confining himself simply to the examination of the students—in chemistry only—the rest of the faculty, reserving to themselves the exclusive right of deciding upon the result of such examination, which was to take place in their presence. To this proposal it was understood, and indeed announced, that Dr. Hare had assented. Whether

the Trustees of the Institution will assent to it also, time only can shew.

This general opinion of the inutility of chemistry to medicine was not confined to the medical faculty in the University. On the very morning of the day that I delivered the ensuing discourse, my friend Dr. Caldwell, whose general talents and standing as a physician, is among the very first class in this city, and whose sentiments are generally understood to coincide with Dr. Chapman's on this subject, took occasion, in a lecture before the students of medicine, to express an opinion that chemistry had been introduced into physiology without any benefit whatever to the former branch of medicine; and that it was hardly applicable to the doctrine of disease, though it might be considered useful in the preparation of medicines to be exhibited in the cure of disorders.

In this state of things, I deemed it an allowable use of my situation as Professor of Chemistry in the Faculty of the Arts, to shew, that there *is* a connexion between medicine and chemistry, and to trace an outline of that connexion. It appeared to me, that the heresy in question ought to be combatted by some one, and I found no one likely to do it, if I did not.

It is not difficult to account for the prevailing opinion; but it appears to me impossible to approve it. When the gentlemen who are now professors, received their medical education twenty years ago, the science of chemistry was truly of very little use or application to physiology or pathology. It is no wonder therefore that the opinion then formed of it,

when they first entered on the practice of medicine, should prevail among them now—or that they should think lightly of a branch of science whose progress they have not traced, and whose present importance they are not sufficiently apprised of. How can they duly appreciate that knowledge which they have been at no pains to acquire, or inculcate its necessity upon others, when they cannot feel that necessity themselves?

But twenty years has changed the whole face of chemistry, in its theory, in its practice, in its application. The physicians of Europe pursue it with increasing ardour, and the bands of alliance between chemistry and medicine are growing every day more indissoluble. Nor is there a school of medicine in Europe where a minute attention to medical chemistry is not considered as absolutely indispensible to a medical degree: and I consider it as a deplorable defect in the medical education of this place, that the same sentiments are not inculcated on the young gentlemen who study medicine here.*

* Extract from a Review of Dr. Marcet's Essay on Calculous Disorders, in the London Medical Repository.—"It is truly gratifying to contemplate "the change of opinion which the last twenty years have produced with re- "spect to the importance of chemical science as a collateral branch of me- "dical educatiou. It is now generally and minutely studied; and the patho- "logist willingly admits, that chemistry, in aiding his labours, has, like irri- "gation, fertilised a soil, which, if hitherto unproductive, was so only, from "the deficiency of knowledge in the cultivators to draw forth its riches. In "no part of medical science, however, has the influence of chemistry been "more conspicuously displayed, than in the light it has thrown upon the "nature of calculi; and the consequent improvements which have resulted "in the treatment of these disorders. *Hence the great value of every work "that can render this species of knowledge more familiar to the practitioner:* "a fact which must plead our apology for bringing before our readers this "volume so immediately after its publication, while many interesting works

Let us consider, what will be the consequence? The prodigious extent to which chemistry is applicable in the arts, trades, manufactures, and domestic economy of life, renders it each day more popular than the past. Every man is alive to its importance, who has an opportunity of reflecting on its uses. The students of chemistry now are confined to no class of society: it is no longer regarded merely as an ornament—an accomplishment: every body is *expected* to know somewhat about it. This progress of attention to chemical knowledge is manifestly gaining ground in this country generally. Hence, in ten years time, chemistry will be better known to every class of society in America, than it will be to the practitioners of medicine poured out from the school of Philadelphia: for at this day they are led to consider it as a very inferior branch of medical knowledge; and they see before them continually, gentlemen of acknowledged talents, who regard it in the same light. It cannot be expected that young men thus instructed should devote themselves to chemistry. But I would ask, how can a physician educated in these opinions meet a jury of his country on a case of poison, or a case of nuisance affecting the public health? How will he be able to maintain the high ground that a physician ought to take, as a member of the most scientific portion of the general community to which he belongs? He cannot.

"of prior date still remain unexamined." See the New England Journal of Medicine and Surgery, No. III. of vol. vii. 1818.

In Europe, in addition to the dead languages and chemistry, botany also is expected to be one among a physician's attainments. It ought to be so here. But when the knowledge expected in a physician is designedly pared down to the smallest possible portion that will give colour to the title, how can our medical men preserve their due rank in the estimation of society? a rank founded on a presumption, and a general persuasion, of superior knowledge connected with the profession?

Whatever may be the opinions of the medical school here—opinions not founded on knowledge of the inutility of chemistry to medicine, but on ignorance of its utility—I earnestly hope for the honour of science in this country, that they will not be supported by the Trustees of this University; who at some future time may feel themselves obliged by the advice which I now take the liberty to offer; viz. that a full share of chemical knowledge be exacted from each student who applies for a degree.

To such of the students who may peruse this pamphlet, I would beg permission to suggest, that every physician is by pretention and profession, a man of science and a gentleman: in his manners and deportment—in his modes and habits of thinking and of acting—well versed in every useful and every liberal kind of knowledge that may serve to qualify him, not merely for the practice of his profession, but for his intercourse with the more polished grades of civilised society, and for the instruction of the neighbourhood where he may

be placed. The people expect from him all the results of a finished education: he cannot support the honour of his profession if he should be deficient in this respect. Even, therefore, if the acquirements I recommend were not necessary, but ornamental merely, they ought to be cultivated by medical students in particular. I hope, however, to prove, that no man can be considered as a well educated physician who is not well versed in medical chemistry: and that this *is* a branch of science of the first necessity in a medical education.

I well know how much a student has to learn, and how little time he affords himself to learn it in. If chemistry be not attended to for want of time at the University, it must be attended to afterwards with fewer opportunities of instruction. For it is in vain to conceal the truth. Chemistry has forced itself into public notice: it cannot be pretermitted: and ten years hence, a physician will assuredly be degraded who is not *well informed* on the subject. No man of sense will permit himself to be deficient in a branch of knowledge, which every physician in Europe is anxious to attain, and to give evidence that he has attained it. If the present portion of time allowed be not sufficient (and assuredly it is not) another year of study ought to be exacted. How often is it, that young men graduate before they are of age?* Opium, mercury, and the lancet,

* The late Dr. Dorsey graduated at nineteen years of age, or thereabout. No credit to the Institution that turned him loose on the world at that early period of life, regularly licenced to tamper with the lives of his fellow citizens. His own good sense, however, corrected the fault: he went to Europe, and attended the Lectures at London and Paris, before he adventured to practice at home.

are instruments too dangerous to be committed thus early into such young hands. Students may rely, that their emoluments as well as their character in public estimation, would be greatly enhanced by an additional year of study and attention. They would have more confidence in themselves, and the public with great reason would have more confidence in them. It is melancholy to reflect that we live in an age thus strongly characterised by superficial acquirement!

I know not how these notions will be received: but I well know that whatever may be their fate now, they will be better thought of the longer they are reflected on, and the more they undergo the test of years and experience. The reader to whom they are submitted, must judge for himself.

THOMAS COOPER, M. D.

☞ *I have just received a note from Dr. Caldwell, of which the following is an extract, viz.*

DEAR SIR,

The following is a correct copy of that portion of my late Introductory Lecture, which relates to the connexion between Chemistry and Medicine.

Chemistry, Botany, Materia Medica, and Pharmacy, ought to occupy two full years of a student's life: Anatomy, Surgery, Midwifery, and the theory and practice of Physic, two full years more. Perhaps the present circumstances of the country will not afford a quadrennial course of study; but if the reputation of the profession is to be maintained before the public, we *must* adopt this period ultimately.

"To some of you, it may, perhaps, appear extraordinary, that I have represented chemistry, as only a collateral element of medicine. It is, however, indisputably, nothing more. When strictly scrutinised, I am at a loss to perceive, wherein it is more intimately connected with medical science, than zoology, botany, or mineralogy. Nor can I recognise any propriety in the expression, "medical chemistry," beyond that of "medical botany, zoology, or mineralogy." The three departments of nature, to which those branches of science relate, furnish the physician with many of his remedies: and, with an immediate reference to his profession, chemistry, unquestionably, does nothing more.

"Shall I be told, that chemistry aids, in the explication of any of the phenomena or laws of the living body, either in a healthy or a diseased state? —that it sheds light on physiology, pathology, or therapeutics? From the most correct and satisfactory views I have been able to form on this subject, I feel myself compelled to deny the position. As far as chemistry has mingled in discussions of this nature, it has not only darkened them, but filled them with error. It has superadded corruption to what it found already sufficiently corrupt.

"Chemistry is, notwithstanding, a branch of science, of such high moment and extensive utility, that it should never be neglected by those who are in pursuit of a liberal education. Whether the destination of the individual be law or politics, theology or physic, his mind will be illuminated,

and his views expanded, by a knowledge of this interesting science. That no professional character may be ignorant of it, its elements ought, in all our higher seats of instruction, to be regularly inculcated, as a collegiate study."

I am much obliged to Dr. Caldwell for this extract: his opinions are manifestly formed on a past, not on the present state of chemical science. As applied to medicine, that science, I acknowledge, is yet in its infancy; but it is the infancy of Hercules. In its infancy it would continue to the end of time, if such depressing, paralysing sentiments were to prevail. Happily, although they may yet prevail here, they are fast declining elsewhere.* Medical chemistry has, in fact, just commenced its career; but such has been its promise of utility, that ten years have increased its votaries at least tenfold. T. C.

* They are supported, to a certain degree, in France, by the Doctors Richerand, Regnaut, Coutanceau; and in Spain, by Dr. Carbonel.

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A DISCOURSE, &c.

GENTLEMEN,

MY peculiar province in this University is to Lecture on Chemistry with its application to Agriculture and the Arts: its application to Medicine properly belongs to the Professor of Chemistry attached to the Faculty of Medicine. But on the application of chemistry to the arts, I have so little to urge that I have not urged already—and I am so unwilling to believe that my years of labour bestowed on the propagation of chemical knowledge in this country have been so far thrown away, that it is necessary at the present day to press the reality of this application, and to demonstrate the connexion between chemical knowledge and agriculture, arts and manufactures—that I am glad of an opportunity of turning my own attention as well as yours, to a topic less obvious and still disputed; and to shew that chemistry is not only applicable to medicine also, but that it is indispensible to a medical education. I am the more induced to take this course on the present occasion, because I know that the importance of chemistry to a medical student, has been, and now is, greatly undervalued by gentlemen of acknowledged talents, and of high standing in this University—whose sentiments on this subject will be regarded by you with great deference and respect—whose advice will guide your studies here, and contribute mainly to form your character, and act upon your reputation in future life. Addressing you, therefore, on a difference of opinion

between myself and gentlemen thus deservedly high in your estimation, it becomes me to lay before you the grounds of my own opinion, and I am prepared on the present occasion so to do.

I hardly know of any opinions that may be considered as forming a school of medicine until the time of Paracelsus and Van Helmont. The aphorisms of Hippocrates, the writings of Galen, the chemistry of the Arabian physicians—can hardly be considered as doctrines peculiar to any class of medical men: they are more practical than theoretical: the doctrines were mere notes of practical observations in pathology, and the medicines exhibited were empirical; not prescribed under any theory of their modus operandi, but because under certain symptoms they had been found beneficial in their effects. Something like exception may appear, but not sufficient to invalidate the general remark.

The chemical notions of Paracelsus and Van Helmont, and the Archæus of the latter, first introduced decided theory into medicine. Cures were considered as performed by chemical operation, and Archæus furnished notice by symptoms and indications of the approach and invasion of disease. This Archæus of Van Helmont, the governor and director of the human frame, is not in any essential respect different from the Soul of Stahl, or the Vis Medicatrix of modern schools. I know no sufficient proof of the one or the other. Vis Vitæ, when confined to the source of excitability in the solids of the organised body, whatever that source may be, is a different thing.

To these notions succeeded the humoural and chemical theories of lentor and thinness of the blood, fermentations, acidity and alkalescence—constituting cacochymia of the fluids, and introducing the irritating spiculæ of saline substances. This inundation of indistinct and unfounded notions and phrases, could not long maintain its ground, though supported in part or

in whole by Boerhaave, Sydenham, Willis, Floyer, Fernelius, and other eminent men of great merit in practice, if not in theory. *Stahl*, the German, though the founder of the chemical theory of Phlogiston, which maintained its ground till the time of Lavoisier, was so sensible of the inutility of the chemical doctrines of the day, that he was tempted, though an excellent chemist himself, to deny the useful application of chemistry to medicine. His notion was, that the body, both in health and disease, was under the government and superintendence of the soul; an opinion in its general form and outline, so like to the anima mundi of Plato, the αρχαια φυσις of Hippocrates, and the Archeus of Van Helmont, that it is not worth while to dwell on the distinction.

Then came the *iatro-mechanical* physicians, Dionis, Borelli, Baglivi, Bernouilli, Pitcairne, Sir Clifton Wintringham, Keil, and Mead, whose physiological explanations were founded on the laws of mechanics.

Hoffman suggested morbid action and spasm of the solids as the causes of disease, but without rejecting the humoural pathology entirely. *Cullen* adopted and extended this doctrine, and applied it to the whole of pathology, gout excepted.

Building on an expression of Cullen's, *Brown* founded his theory of excitability, accumulated during rest, and exhausted by stimulus, natural or artificial. According to him, life is a forced state; and health consists in excitability perpetually renewed by food and sleep, and gradually used up or consumed, by the moderate action of natural stimuli applied to the animal fibre. When the excitability or the stimulus is in over proportion, sthenic disease is produced: when excitability is deficient, then there is asthenic diathesis; when excitability is too much exhausted by the application of stimuli, we have indirect debility, or asthenia. Hence, Therapeutics, with Brown, were

guided by four indications only, excess or defect of excitability—excess or defect of stimulus.

The excitability of Brown does not seem materially to differ from the irritability of the muscular and the sensibility of the nervous fibre, on which *Haller*, *Whytt*, and *Girtanner*, have laboured so successfully. Nor does it differ from the sensorial power of *Darwin;* for Brown also derived his excitability from the nervous fibre and medulla.

Darwin modified the former theories by rejecting altogether the humoural pathology, and ascribing the phenomena of health and disease to irritative, sensitive, voluntary, and associated motions in the sensory,—and correspondent motions in the muscular and other fibres: herein connecting the theories dependent on irritability and sensibility, with the association and catenation of motions, first explained and illustrated by Dr. David Hartley in his most important book on the association of ideas.

Thus stood the state of medical science about 20 years ago; the doctrines of the school of Edinburgh, as taught by Cullen, maintaining the predominance; the followers of Brown and Darwin being numerous, but forming no separate and distinct school; such also was the case with the medical school of Philadelphia, the leading feature of Dr. Rush's theory being, that pathology is reducible to the morbid action of the living solids. The humoural pathology, with its cacochymia, lentors, fermentations, and spiculæ, could no longer be supported by the imperfect chemistry of the day. In Edinburgh, in London, and in Philadelphia, almost every body was willing to subscribe to Stahl's opinion, *Chemiæ in medicinâ, ferè nullus est usus.*

Is it any wonder then, that gentlemen educated at a period when chemistry was regarded as a visionary branch of medicine, and the humoural pathology founded on it, banished from the schools by common

consent, should retain their prejudices against studies that they were led to consider as useless and absurd?

But although this neglect of medical chemistry may be well accounted for, certain it is, that no such objections exist at present among those members of the medical profession who have taken due care to keep due pace with the knowledge of the day; and who have qualified themselves, to understand and to teach, what has now become indispensible for a student to learn. Professors and practitioners of medicine, in every part of Europe, are now alive to the claims of chemistry, too imperious in its present improved state to be neglected. The time has arrived, when, however reluctantly, we must retrace our steps: nor is it difficult to shew that even the humoural pathology, stands upon much higher ground than those who smile at the application of chemistry to medicine, are willing to allow, or able to deny.

I well know that the sentiment I now advance has been rejected in Europe for near half a century: I know that it is heresy to the ears of all who are now present. But I know too the ground I stand upon; and having reflected on the subject, though aware of contradiction, I am in no fear of confutation.

The modern doctrine in this country is, that the cause of disease must be sought for alone in the irregular and unnatural action of the living solids, and never in the fluids of the body.

I am well aware, that the living fibre of the animal system, possesses properties that no chemical or mechanical philosophy can explain: that the sensibility, the irritability, the vitality of the living fibre, are not chemical properties, though liable to be called into action, deranged, and destroyed, by chemical as well as by other stimuli: that health and disease depend chiefly on the regular and natural, or on the irregular and disturbed action of the animal fibres, whether separately, or collected into an organised congeries:

that the condition of the fluids absorbed, and the fluids secreted, depends mainly on the condition of the absorbing and secreting vessels: and if morbid fluids and humours appear, they are very frequently, if not generally, the consequence of morbid action in the solids.

I am well aware too, of the mutual and specific connexion of the solids with each other in various parts of the body. I do not ascribe to chemistry the sympathy of the skin with the stomach, or the headach of indigestion, or the pain down the thigh when the kidneys and ureters are affected, or the gout in the toe on drinking a pint of claret or champaign, or the affection of the left shoulder in hepatic obstructions, or the connexion of the digestive organs, or of animal heat, with the nervous energy—or a hundred more instances, that demonstrate the association and catenation of morbid sympathies, too strongly to be doubted. The position I assume is, that when the humoural pathology prevailed, it sunk under the task of accounting for every morbid phenomenon: when it was rejected for morbid action in the living solids, the theorists who rejected it, did not understand it thoroughly, or they would not have rejected it in toto: that the present fashionable doctrine of morbid action will in its turn sink under the weight imposed on it, of explaining every appearance of disease; and that there is too much truth both in the one doctrine and the other, to reject either altogether.

An instance to illustrate this morbid action (if I may so call it) of medical theory on our opinions, may be taken from the gout.

At first, this disorder was supposed to arise from morbid acrimony contained in the fluids of the body, and therefore venesection, cathartics, and diaphoretics, were resorted to. Well, who can doubt of morbid acrimony, who has seen the deposition of lithat of soda called chalk stones?

Then it was supposed to arise from the irritation of acid spiculæ deposited on the inflamed part. Well, who doubts in the present day of a morbid secretion and formation of acid in the gout?

Then it was supposed to arise from a morbid accumulation of lithic and uric acids in the system, aided by stimulating and acid drinks? Well, who doubts this who knows that the substance called urea is not secreted in usual proportion in a gouty diathesis, and that acids taken into the stomach uniformly promote the disease?

Then it was supposed to arise from a plethora in the system of the vena portarum, affecting the secretions of the liver! Well, can it be doubted for a moment whether gout be attended with venous plethora?

Lately it has been ascribed to morbid sympathy with the overloaded state of the stomach and bowels! Well, who can doubt this entering into the sources of gout, who knows how frequently a fit is prevented, and how certainly it is shortened by due attention to the state of the stomach and intestines?

It is intolerance that is the bane of improvement. Intolerance in politics, intolerance in religion, intolerance in medicine. Those who deem themselves entitled to the patent right of a system, will admit of no competitor and no sharer. Every thing must be done and explained by the *sole* instrumentality of their exclusive method.

Hence these, my admissions of modern claims, do not exclude the doctrine in question. The fault of all system-makers is exclusiveness. New theories explain every thing: new remedies are panaceas: hence the propensity in all of us, to reject what is useful, from its occasional alliance with unfounded pretension.

But the humoural pathology, which admits that the causes of disease may exist in the fluids as well as in the solids of the body, stands, as I suppose, upon ground too firm to be shaken.

The animal solids act when they are stimulated to act: I admit that disease does consist in morbid action. Admitting this, I proceed to the argument.

1. Such as the fluids are, such are the solids: for they are all formed out of the fluids; and their tendency to obey the action of appropriate stimuli, depends on their composition, *i. e.* on the constituents of the fluids.

2. All the *solids* are stimulated into action by the fluids: the action thus produced will follow the character of the producing cause.

3. All the *secretions* will follow the kind and degree of stimulus applied to the solids which secrete them; but that stimulus is contained in the fluids of the body.

4. All the *natural* stimuli that excite the organs of involuntary motion are contained in the blood: that blood is formed from the chyle; the chyle from chyme of the food mixed with the juices of the pancreas and the liver. Such as the food is, such is the chyle, and such is the blood; and such is the stimulus to the living fibre. Is not this manifestly the case in sea-scurvy, gout, &c.?

5. The living fibre is liable to be stimulated *artificially*, by all saline chemical substances, by alkalies, by acids, by earthy and metallic neutrals, by galvanism, by common electricity, by the gases.

6. The quantity and kind of these saline stimulants in the blood, depend greatly on the nature of the food.

7. Chemical changes, compositions, and decompositions, acid, alkaline and neutral, do in fact continually take place in and from the fluids of the body, such as the lactic, phosphoric, muriatic, fluoric, sulphuric, and lithic acids, and their compounds with soda, potash, lime, magnesia, and ammonia.

8. The whole mass of fluids as indicated by the urine and perspirable matter, can in three or four days be altered in character from acid to alkaline, and vice versâ: their stimulant properties must be altered in proportion.

9. This heterogeneous mass of saline chemical stimuli, of chyle, and of carbonated blood, is mingled together in the left subclavian vein, and is ultimately animalised by decarbonisation in its passage through the bronchial vessels of the lungs: then, and not before, it becomes, when thus mingled and combined, a stimulus to the left ventricle of the heart, as Goodwyn has rendered probable. The kind and degree of its stimulating power must depend on its composition: that is, whether it stimulate too much or too little, morbidly or healthily, depends on its composition: that is, the locality of the source of morbid action, is in this compound fluid.

10. The living fluid blood is not only a stimulus to the living solid fibre, but it is itself capable of being stimulated, and of being formed into a vascular body: as in the *healthy* process, where it unites living parts; and in the *morbid* process, of the last stage of cynanche trachealis.

11. Sir E. Homes's late experiments tend to shew that medicines act in many, if not in most instances, by being received into the mass of circulating fluids: and they corroborate the observations to the same purpose of Mr. J. Hunter, illustrated by his case of Morgan the painter: and still later by the discoloration from nitrate of silver, related by Dr. Albers and Dr. Roget, 7 Med. Chir. Trans. 284.*

12. Many poisons act on the solids while commingled with the fluids, as in the variolous, siphilitic, the scrophulous, the cancerous, when absorbed into the system; whether general or lymphatic.

Lastly, all medicines, in fact, are either stimuli, in-

* The same position is supported by a numerous collection of facts in the Inaugural Dissertation of Dr. Edward Darrel Smith, of Charleston, S. Carolina, now Professor of Chemistry in S. C. College. See also Dr. George Cheyne's case of the absorption of mercury, in his treatise on the *English Malady*, p. 343, and Dr. Egan's cases of absorption in the Royal Irish Transactions, and in vol. xxiii. of Tilloch's Phil. Mag.

creasing action, or sedatives, diminishing action of the living fibre: and they are always, if possible, exhibited in a fluid form, in conformity with the chemical axiom, *corpora non agunt nisi soluta.*

But nothing is more frequent or notorious than that they sometimes act too violently, and increase the disorder: that is, the fluids thrown into the system frequently excite to morbid action; that is, they are the exciting cause of disease.

All these arguments might be dilated on and illustrated by cases, but the space of an introductory lecture admits only of an outline: an outline, however, that sufficiently proves the fluids of the body may be diseased themselves, and may produce morbid action in the solids.

Hence, without denying the effect of vitality, it may well be maintained that the chemical affinities and the stimulating properties of the substances that compose the animal fluids, are not annihilated; on the contrary, they exert their full effect within the body: for if their action be modified by the vital powers, they in return modify the vital powers themselves. This may require illustration. It is an universal law that action and reaction are equal and contrary. Thus, suppose chemical attraction be counteracted by the attraction of cohesion: the attraction of cohesion is proportionably weakened by its resistance to the tendency of chemical affinity: the same law takes place as in the quiescent and divellent forces of the component parts of two chemical compounds. So, when chemical affinity is counteracted by the action of the galvanic fluid, that fluid is expended in the process. When chemical affinity is modified by the polarity that produces crystallisation, an alteration in the form of the crystal is occasioned by the chemical attraction of the molecules: hence, in mineralogy, the varieties of form, in substances apparently similar in composition. So in the animal body; chemical

affinity in the fluids is counteracted, 1st. By the perpetual flux of the particles whereof the body is composed, their absorption, secretion, renewal by assimilation, &c.: so that in most cases the necessary portion of time for the attractions to take effect is not allowed. 2d, By galvanic and vital action; which are probably nearly allied.

In return, these properties of living matter are modified by the chemical affinities of the substances subjected to their action: but all this may take place (according to the circumstances) either within or without the limits of healthy action: and in the latter case, the *fluid* will contain the causa morbi, and originate disease.

To those who have studied the laws of chemical affinity in connexion with the laws of the animal economy, these conclusions are too plain to be doubted: but to those who have rested content with the imperfect knowledge of past times, and who have despised animal chemistry too much to study it, these conclusions will be inadmissible, because they will be unintelligible.

I proceed now to shew the more immediate connexion of chemistry with medicine, in its relation to physiology: pathology, semeiology and therapeutics: poisons: mineral materia medica: vegetable materia medica: the adulteration of medicines: pharmacy: and prescription.

1st. Physiology: wherein we may consider briefly the doctrine of respiration: of animal heat: of the circulating fluids: of the bile: of the urinary secretion of the bones or skeleton: of the coats of the arteries: of the circulating fluids generally.

Respiration. Of respiration and its uses, nothing was known, until the fine experiment of Dr. Priestley, shewing the disappearance of oxygen when exposed to venous blood inclosed in a thin bladder, and the florid colour thus produced. At present, how-

ever, we know tolerably well, that the air inspired is little changed in quantity: that the oxygen is converted into carbonic acid: that a small quantity of additional moisture is contained in the expired air; and that it is thus fitted for stimulating the left ventricle of the heart. At this period, and not sooner, does the chyle assume the properties of the blood; whether a repetition of this process be necessary to furnish a full share of vitality to the chyle is not yet fully known. But it is certain, that the chemical formation of albumen and fibrin from their elements in the chyle, does not fully take place till this fluid be acted upon by respiration and assimilated with the blood in the arterial system. So that without a knowledge of the chemical composition of the chyle and of the blood, and the chemical effects of respiration on these fluids, we must remain in utter darkness as to the processes taking place. Whatever is known of these processes, we owe to chemistry, and to chemistry exclusively.

Animal heat. The first experiments that threw light on this difficult subject were those of Dr. Black and Dr. Crawford. These experiments, with some late ones of Sir H. Davy, inform us, that, not only the specific heat, but the temperature of arterial is greater than that of venous blood. That Crawford was mistaken in supposing oxygen to be absorbed because it disappears, is now well known; but the facts above stated are considered as established. As in the case of all other theories, the heat of the animal system was, in his day, explained exclusively from the caloric deposited during the course of arterial circulation. The general chemical law was unnoticed, teaching us, that whenever a fluid is converted into a solid, caloric is given out; so that the renewal of each particle of the solid parts of the body must prove a perpetual source of animal heat. But although this seems to be a full, an adequate, a reasonable source for the supply of warmth to the animal system, it is not ex-

clusively so. The late experiments of Le Gallois, Wilson Philips, Brodie, and Earle,* shew decisively the influence of the nervous energy over the secretions and other functions of the body; and that mere chemical considerations, though indispensible to account for animal heat, will not suffice alone to explain the phenomena: unless, indeed, the nervous energy should hereafter prove to be a galvanic process, of which the evidence, as yet, is incomplete.

Of the Blood. All we know as yet of the process of sanguification, and the contents of this compound fluid, we owe to chemical investigations. We know that it contains much albumen and fibrin, of which we can trace little in the chyle until its entrance into the left subclavian, at its junction with the carotid; and but traces of it supplied by the lymph, even there we know that the colouring matter of the blood alone absorbs oxygen; and that the serum carries with it fibrin to renew the waste of parts it is destined to supply (Berzel. An. Ch. 36—46). Indeed every secreting gland is a chemical laboratory; nor is it possible to refer the changes that take place in the fluid that enters a gland, to any other than chemical and galvanic agency: for decomposition takes place, new compositions appear, with perfectly different properties, and with different chemical elements, and caloric is given out in almost every case. We know that the play of chemical affinities can do this, and we know of no other power competent to it. These changes constitute the essential characters of chemical affinity.

In considering the serum of the blood in a chemical point of view, it is worth observation that though it contains fibrin and albumen for the purpose of supplying the wants of solid parts, it contains no gelatin. This Bostock and Berzelius have shewn. But the skin, the cartilage, and various membranes of the

* 7 Med. Chir. Trans. 284.

body, do contain gelatin; hence from five to six per cent. of carbon must be separated chemically from albumen and fibrin, to convert them into gelatin. A direct and incontrovertible proof, among a hundred others, that the play of chemical affinities goes on perpetually within the body, without interruption from vital power.

Of the Bile. This is secreted by the action of the liver from the blood which the vena portarum brings to that viscus. The bile is described to be, a yellow, or greenish, and sometimes a colourless fluid. I shall venture the assertion, that it never is greenish, or colourless, but in consequence of a morbid state of the blood brought to the liver, or morbid action of the liver itself upon the fluid thus supplied. I am persuaded from many experiments of my own and of others, that *green* bile, in the stomach, in the intestines, or in the bladder, is in all cases owing to the chemical action upon the bile of an acid introduced too largely in the food, or morbidly formed, or secreted, and in either case chemically combining with the yellow bile. A remark of very great practical consequence, as I deem it, and as I shall note again, in the semeiology of disease.*

Urine. This secretion would demand a volume to treat all the important questions concerning it at full length. To chemistry, we owe our knowledge of the general composition of healthy urine: and to chemistry, we owe all that is known of the variations that take place when urine is secreted, either from animal fluids that are morbid stimuli, or by morbid action of the kidneys from healthy fluids. When we find this secretion composed of urea, of uric acid, of muriatic, lactic, and phosphoric acids, of combinations of these in the form of saline neutrals with soda, potash, magnesia, lime, ammonia,—and in disease, albumen,

* On the use of chemistry, as applied to the bile, see Dr. W. Saunders on the Liver.

gelatin, mucus, and sugar—and that these vary in their proportions according to the state of sickness or health of the person secreting this fluid—when we have no means of ascertaining the differences of its composition but chemical analysis—and when those differences indicate various conditions of health or disease, we may surely be permitted to say that an accurate knowledge of animal chemistry is indeed necessary to the medical profession.

Of the Bones. It is principally to Scheele we owe our knowledge of the chemical composition of these substances; consisting chiefly of phosphate, and slightly of carbonate of lime; and in the enamel of the teeth, of fluate of lime; besides the fat, the gelatin, the cartilage and the water, entering into the composition of bone. To his experiments also we probably owe the knowledge we possess of Rachitis, its proximate cause and probable remedies.

Of the arterial coats. It was for a long time supposed, and I doubt whether there be yet a general agreement on the question, that beside the elastic coat of the arteries, a muscular coat also accompanied these vessels, whose alternate contraction and dilatation aided the systole and diastole of the heart. From the application of the usual chemical stimuli that excite action in the muscular fibre, no effect was produced on the supposed muscular coat of the arteries in the experiments of Bichat. Hence, it is probable that the arterial coats are endued with an elastic power only, and not with the contractility usually observed in muscular fibre. I remark this solely for the sake of illustrating, how variously chemical agency can be employed, in determining physiological questions.

Of the circulating fluids generally. All these are formed out of four principal fluids that compose the chyle as it enters the venous circulation. 1st. Of the chyme formed in the stomach from the food thrown in. This must of course depend on the nature of that

food. The decomposition of that food, and the new compositions formed out of it, cannot take place but in consequence of chemical affinities of the substances thus acted on, aided by the vital power of the stomach itself. The diathesis, whether of health or disease, must of course greatly depend on the nature of the food employed to satisfy the calls of appetite. In fact we find it so. An American Indian who lives upon animal food, and an East Indian who is sustained by rice, have very different temperaments, dispositions, and habits.

2d. Of the pancreatic juice: 3d. Of the bile: 4th. Of the lymph. Each of these fluids before mixture, and their combination afterwards, must greatly depend on the chemical nature of these separate fluid substances, and particularly of the chyle. For we well know that saline substances taken into the stomach, whether alkaline, acid, or neutral, will frequently retain their composition and properties unchanged: and in other cases, will be subjected to decomposition and new arrangements of their elements. It is on this principle we exhibit alkaline and earthy absorbents. But all saline substances are stimuli more or less in degree, to the living fibre; and therefore the action of the living fibre will greatly depend on the nature of the food taken in, and the nature of the chyme formed out of it.

That saline substances, acid and alkaline, may pass through the course of circulation, unchanged as to their acid or alkaline character, is certain, if there be not a double passage to the bladder; a fact suspected but not ascertained. Whether the ingenious experiments lately devised by Dr. Dorsey, will settle this long litigated question, we shall know when he thinks fit to lay them before the public.*

* Since this Discourse was delivered we have to lament the premature decease of this amiable and very ingenious man, whose talents promised so much benefit to the Institution to which he belonged.

Dr. Chapman (Therapeut. vi. p. 284) expresses himself thus: "My present view of the subject is "perfectly consistent with the doctrine I delivered in "the early part of these discourses, that no substance "enters the circulation with a retention of its original "powers. To me it is still most manifest, that the "process of the assimilation, whether performed by "the chyloposític viscera, or by any part of the ab-"sorbent apparatus, completely animalises all articles "subjected to its influence, and however various in "their composition, reduces them to one homoge-"neous fluid, bland in its nature, and fit for the pur-"poses of nutrition. But in the secretions and ex-"cretions, being removed beyond the sphere of the "vital powers, chemical action takes place, by which "those substances are in part or entirely regenerated."

Dr. Chapman's known and acknowledged talents, which no one is better aware of than myself—the merit of the book in question—and the high standing he bears in this University, render his opinions of great importance. The conjectures here quoted are directly opposed to the numerous facts collected by Dr. Edward D. Smith; to the case I have cited from Cheyne and John Hunter, and to the effects of nitrate of silver related by Dr. Albers and Dr. Roget in the Medico-Chirurgical Transactions.

2dly. There is no proof whatever for this strange and novel opinion, that the processes of secretion and excretion are removed beyond the sphere of the vital powers; but directly the reverse. 3dly. We know of no process by which any acrid substance decomposed and rendered bland by assimilation, can be in part or entirely *regenerated* by the processes of secretion or excretion. There is not one solitary fact in support of this opinion. 4thly. If it be so, then the vital powers of assimilation are employed in decomposing chemical substances and rendering them bland; and the secretory and excretory powers (which

according to Dr. Chapman are not vital, but removed beyond the sphere of vital action) in recomposing these chemical substances, and restoring their original properties. It is not my business to contend for the truth of these opinions of Dr. Chapman, but if they be true, then is the organised body, even according to Dr. Chapman himself, a chemical laboratory; and nothing but the laws of chemical affinity can explain the phenomena.

For my own part, I am well persuaded that acid and alkaline substances do pass the usual course of the fluids unchanged, because by a course of alkaline remedies for gouty diathesis, I have repeatedly in the course of three days, changed the character not only of the urinary secretion, but also of the perspirable matter, as appeared when subjected to the test of blue litmus paper. Hence I suspect it as a law in the animal economy, that the healthy action of the living fibre in the organs of the body effects no decomposition or new composition of chemical elements, but such as the wants of the animal economy call for: such as the separation of calcareous earth and phosphoric acid for the use of the bones: of gelatin for the cartilage and skin: of albumen and fibrin for the muscles: of mucous and synovia for the mucous membranes and joints, &c.: but when that action is morbid, whether from a primary disease in the organ or fibre, or from the stimulus of acrid fluid exciting it to unhealthy action, then secretions and formations of morbid matter occur; as in acrid effusions into the stomach, intestines, and lymphatics—ichorous secretions from ill conditioned sores—excrescences of various descriptions.

In *all* these processes, whether of health or disease, not only the vital principle appertaining to the living fibre of the animal body, but the chemical affinities of the substances brought within the sphere of action of the vital principle, are equally concerned. This I

consider as demonstrated, 1st. Because the existence of the vital principle, whatever it may be, is undeniable: 2dly, because the chemical affinities of the inorganic matter taken within the body are equally undeniable: and, 3dly, Because the effects produced cannot possibly be accounted for without taking both sets of action into view.

Hence, also, it follows with equal force, that a knowledge of physiology depends at least as much on the effects of animal chemistry, as on the laws of excitability and vital action.

It is manifest that in this brief and hasty sketch of the connexion of chemistry with physiology, innumerable facts of illustration must be passed over for want of time: and the same apology must be made for the slight outline to which I must confine myself in the subsequent parts of this discourse.

I proceed then to chemistry as connected with *pathology*, merely touching upon a few of the morbid affections of the body, to shew in what way chemistry bears upon the subject. Always premising, that when I propose to shew the use of animal chemistry, and thence to deduce its absolute necessity as a part of medical education, I certainly mean, that the well known properties of the living solids constitute a branch of study equally necessary. I agree too, that much useful knowledge of the theory and practice of medicine may be obtained, consistently with even a moderate attention to the chemistry of the animal body. In like manner much knowledge of empirical practice can be acquired, without any just views of the physiology and pathology of the system. In this way, a man may pass through life with tolerable eclat as a village practitioner, just as a knowledge of the minutiæ of legal practice may suffice for a county-court lawyer: but no branch of the profession will be neglected by those who feel it their duty to stand upon higher ground; and to make the best use of the op-

portunities which it is the duty of every medical school to afford.

The *yellow and bilious* fevers form a prominent feature among the diseases of the warm climates of the United States. A hot sun, acting upon a plethoric system, either conjoined or unconnected with marsh miasmata, may be considered as the exciting cause of these diseases, of which the more immediate seat is the liver. In all these cases, the effects of intense heat and miasmata, are greatly aided by the venous plethora of the vessels that supply the liver. Hence, persons of a sanguine temperament and full habit, are most liable to danger. In this case the liver secretes morbidly: by over excitement in the first instance, and by indirect debility afterwards. But the effect of these causes operating upon the liver, induces also a morbid secretion of acid in the stomach, probably sympathetic. In which case, a train of symptoms come on, that ultimately form the most serious part of the disease.

Chemical experiments shew, that the acids formed in the human body when strong, have this effect upon the bile. 1st, They turn it of a green colour: 2dly, They precipitate from it a resin, insoluble in the fluids of the body, and soluble in alcohol. (Berzel. 66.)

By degrees, in the higher stages of the bilious type of fever, such as the *yellow fever*, this acid forms the most constant, the most distressing, the most painful, and the most dangerous part of the disease. It is this concentrated acid, setting the teeth on edge,* and excoriating the lips, that acts on the stomach in yellow fever, disorganising and destroying the coats of that organ, and converting them into the dead matter of the black vomit.

* In the report of the Physicians of New Orleans respecting the yellow fever that prevailed in that city in the summer of 1817, they describe the acid of the stomach as *agacant les dents: excoriant le bouche:* and the ejections as green.

This peculiar symptom of morbid acid has been greatly neglected in the cure of these disorders, particularly by the foreign physicians who have practised here. A habit of considering the phenomena chemically, would have substituted alkaline diluents for acidulated ptisans; and by counteracting that symptom which ultimately forms the most serious part of the disease, have saved many who have probably been injured by the acid medicines meant to promote their cure. This I have observed particularly in the reports of cases from New Orleans.*

These remarks apply in a less degree to the milder forms of *bilious* fever, in all of which, insoluble resinous matter precipitated in the primæ viæ, and morbid acid formed in the stomach and intestines, produce a train of symptoms that a recurrence to the known facts of chemical affinity will alone be competent to combat. The same observations will apply to the numerous forms of *dyspepsia:* one of the most troublesome symptoms of this proteous disease, being a morbid secretion of acid in the stomach, which in its turn acts not only upon the contents of the intestines, but on the mouths of the vessels that open into them, either to pour out their contents from the pancreas and liver, or to absorb the fluids of the intestines into the lacteals. It is upon this principle only, that we can account for the use of magnesia, soda, and lime, in dyspepsia and its attendant symptom cardialgia.

The same secretion of morbid acid takes place in diarrhœa, in dysentery, and in cholera: hence, in these diseases, the manifest use of alkaline remedies, and particularly of the chalk mixture: for although the symptom be not the disease, it may when neglected,

* When the yellow fever is at its highest grade, little hopes are to be entertained. Probably, if called in early, the best general treatment is, full bleeding: strong purges of calomel and jalap in doses to ensure the speedy effect: then cold affusions over the whole body; and afterwards saline cathartics, and alkaline ptisans.

and it frequently does become a disease itself, equal in importance to the cause that gave it birth.

In *dysentery*, the astringent remedies of terra japonica and kino are sometimes usefully given.* There is every probability that these remedies act upon the same chemical principles which forms out of the body the substance called leather: viz. the tannin precipitates and combines with the gelatinous and albuminous secretions of this disorder, and closes the mouths of the vessels that morbidly secrete them.

It is surprising that the obvious source of *chlorosis* has never been considered in a chemical point of view. I am not disposed to deny hysteric sympathy acting on the stomach; but it is in the stomach and intestines that this disorder is located. Is not this obvious from the craving of the depraved appetite for chalk and absorbent earths? Does not this morbid appetite point out the acid source of the immediate symptoms? and does not the name itself indicate the chemical action of acid on the bile?

Those who have attended or experienced cases of *hemorrhoid*, well know the burning pain that annoys the patient in the region of the rectum: a pain whose cause is the acid nature of the fecal discharge; and which is severely felt when it passes over the inflamed tumours that characterise this disease. Is it not evident that chemistry must supply the remedies to neutralise this morbid and distressing secretion?

I have seen so many cases of *hysteria* to which these remarks apply, that I consider it as a species of dyspepsia, and to be so treated, whether it originate in the primæ viæ, or whether this part of the system be affected by uterine sympathy.

* There are three modes of combating dysentery. 1st, By ipecacuanha and emetic tartar, determining to the skin. 2dly, After bleeding, and alkaline purgatives if indicated by the pulse and primæ viæ, the exhibition of catechu (terra japonica) as an astringent. 3dly, By the exhibition of saline purgatives and alkaline remedies during the day, and the injection of laudanum in the evening. I have seen them all succeed.

Indeed, the more I see of disease, the more I am led to agree with Fernelius in his treatise on the general method of curing fevers, and who thus comprises the sum and substance of the *ratio medendi* suggested by the humoural pathology, of which he was a distinguished advocate. *Omnis enim cacochymia, et humorum impuritas, aut ex vitiosâ viscerum affectione, aut ex improbâ vivendi ratione, rarò aliis ex causis, proficiscitur.* That is, all morbid concoction and impurity of the humours of the body, proceeds either from a diseased affection of the stomach and viscera, or from a gross and faulty diet. In fact, the most recent and the most eminent of the English physicians, Hamilton, Scudamore, Wilson of Kelso, and Carlisle, consider the stomach and bowels as the immediate source of almost all the disorders to which mankind are subject; and that diseases apparently of a very different origin arise from the morbid sympathies that take place from the acrimonious contents of the primæ viæ and the intestinal canal.

Of Gout. I have already enumerated the theories to which this disorder has given rise: all of them telling us the truth; none of them telling us the whole truth.

The facts hitherto observed seem to establish, that this disorder may arise, 1st, From hereditary diathesis; inducing a tendency to venous plethora and its consequences; viz. morbid action in the liver, and morbid action in the stomach, causing acid secretion.

2d. From morbid action in these viscera, the consequence of a similar diathesis brought on by habitual indulgence in too much rich food, and stimulating drink.

3d. From these exciting causes operating particularly at the middle age and decline of life, when the vital energy becomes too weak to overcome the oppression of daily indulgence.

4th. That acid wines, and all kinds of fermented

liquors, received into the system, are there converted into lithic and uric acids, giving rise not merely to morbid and arthritic acrimony in the fluids, but to the separation of lithates and urates in the joints and in the bladder: a fact which cannot be denied, because the chalk stones of the joints, and the calculi of the bladder, are visibly separated from the circulating fluids; chalk stones, moreover, have been dissolved by caustic alkali, and again carried into the circulation.

All that we know of the composition and formation of these productions of gout and gravel, we owe to chemistry alone: and, cathartics excepted, all the remedies hitherto suggested, have been furnished by chemistry, on chemical considerations: the same may be said not merely of the remedies but of the prophylactics also. In fact, without chemistry, nothing would have been known of the theory or the cure of gout, stone, and gravel; although, as I allow, other considerations may enter into our view, as gastritis, hepatitis, and nephritis, whether owing to original affection, to metastasis, or to sympathy.

Dr. Chapman, in his Therapeutics, when treating of the calculus of the bladder, after giving some credit to the discoveries of chemistry on this subject, observes thus: "Of the many difficulties incident to the "case, not the least is to determine the composition "of the existing stone in order to select the appro- "priate solvent. As we have no precise mode of "doing this, we shall be compelled to practice empi- "rically, experimenting with one and another sub- "stance, without rule or principle, till we hit upon "some one which may answer the purpose." Chapman's Therapeutics, vol. i. p. 280.

I believe Dr. Marcet's modes of analysing urinary calculi had not then appeared, which removes almost entirely the difficulty Dr. Chapman complains of.

How absolutely necessary it is with a view to this

disorder and its relations to the gravel and the stone, to know how to analyse the bile, and the urine, as well as the various kinds of calculi, is made evident in the last edition of Dr. Scudamore's treatise on the gout, beyond all doubt the most satisfactory that has yet appeared.* Owing to the want of chemical as well as pathological knowledge generally, patients in this disorder have been from time immemorial the prey of quacks out of the profession and empirics within it. But whether the remedy of the day be Mrs. Stephens's medicine, which is the best of them, or the Portland powder, which is the worst of them, or the Eau Medecinale and infusion of colchicum, which are of the same grade—whether prescribed by M. Husson in France, or Sir E. Home, or Dr. Want, or Dr. Wilson in England, or by Mr. any body in America, they are quackeries—useless in the hands of skilful men, and most dangerous in the hands of common men: the best opinions and observations agree that, in every case whatever, if they shorten the paroxysm, they lengthen the disease. As it appears to me, no physician is justified in prescribing a remedy for any disorder whatever, but on enlarged views of the pathology as connected with the physiology of the system; either, on the known properties of the living organ when stimulated into action—or on just views of the chemical decompositions and combinations that may reasonably be expected *within* the system, from the exhibition of the remedy proposed. The time has been, but it has passed, when empirical remedies might have been excusably prescribed; but I doubt whether they are allowable in the present improved state of medical science. I forbear to apply chemistry to the gravel and the stone in the bladder, in this brief lecture, because excepting the symptoms produced by nephritis, every thing we know of the cause, the symptoms, and the cure of these disorders, we are

* See also Sanders on the Liver.

indebted to chemistry for, exclusively; and the time occupied by this lecture would hardly suffice for even a brief review of this single branch of our general subject. Dr. Chapman's observations on these disorders, however, (Therapeutics, vol. i. p. 281) induce me to remark, 1st. Dr. Hale's experiments shew that the stone of the bladder, tried by him, was easily dissolved by caustic alkali: 2dly. That Dr. Chitty's broth, which contained only caustic alkali as a remedy, was indubitably of service in calculous disorders: so was Mrs. Stephens's medicine acting on the same principle. 3dly. That I have no doubt of alkaline remedies passing unchanged into the bladder from my own repeated experience.

Diabetes mellitus. Dr. Henry, in the 2d vol. of the Med. Chir. Trans. remarks from the experiments of Messrs. Nicholas and Guadeville, as well as from those of Dr. Wollaston, that the serum of diabetic blood does not contain sugar. Hence the kidneys do not separate the saccharine fluid, but it is chemically formed during the passage of the blood through these organs. Farina is a common article of every body's food; and we know from the experiments of Kirchoff repeated on a large scale in my laboratory, that farina is converted into sugar by digesting it with an acid. Dr. Rollo has certainly struck upon the chemical remedy which suits this theory, as well as the disease itself, viz. the deoxygenising property of animal diet, and the alkaline sulphurets. The experiments and analyses of Dr. Henry are of great importance to the pathology of diabetes and dropsy.

Pthisis. I fear we know of no cure for this disorder, when decidedly characterised, and combined as it usually is with scrophula. Hydrogen has certainly relieved the symptoms; but it is of importance to know when the disorder *is* in reality well characterised: and when the expectorated matter proceeds from tubercules already formed, or merely from an increased secretion of mucus owing to incipient inflamma-

tion. On this point, as on many others among surgical cases, the experiments of Drs. Pearson, Bostock, and Berzelius, on the distinction between pus and mucus, deserve great consideration.

In Rachitis we know that a due proportion of phosphate of lime is not secreted and deposited where nature calls for it; but I dare not say that chemistry has yet discovered the remedy, though she has made us better acquainted with the disease.

I cannot, and you cannot, afford the time necessary to enable me to run even hastily through the whole system of nosology, to point out each particular disease whereof chemistry has ascertained the cause, the nature, or the cure. The general view I have already taken, comprehends so many varieties of morbid affection, that I fancy it may by this time be considered as proven, that a knowledge of medical chemistry is at least highly desirable, if not absolutely needful to the physician. But we have not yet done.

Poisons are either mineral, vegetable, or animal. Few of these are given, and few are taken, except the mineral poisons. For the vegetable poisons, after emetics, strong vegetable acids seem the most proper as a general class of medicines: they seem powerfully to counteract the narcotic class of poisons; and I have repeatedly eaten in substance as a pickle, this summer, the momordica elaterium, whereof one grain of the extract is a drastic dose.

Of the animal poisons, and of the poisons indeed generally, we know nothing but what chemistry has furnished us. Dr. Mead, Dr. Ramsay, the Abbè Fontana, Mr. Russel, and Mr. Brodie, have thrown light upon some vegetable and some animal poisons and their modus operandi: but it is with the mineral poisons, arsenic, sublimate, copper, and lead, that physicians have most frequently to deal. *Are* there any means, *except those which chemistry affords*, of alleviating the sufferings of a poisoned patient during life,

or of detecting the nature of the poison after death? Some physicians have pretended to ascertain the existence of poison, and the nature of the poison by the morbid appearances on dissection. But these methods of discovery, when relied on alone, have been so decidedly shewn to be equivocal and ambiguous, that I fancy no physician who has a character to lose, would hazard it by such testimony. Moreover, all who hear me, are liable at one time or other of their lives, to sit as jurymen upon a case of poison, or to be called on as physicians to give testimony in such a case, upon oath. I will suppose a physician thus brought before a coroner's inquest, or a traverse jury on an indictment. He will probably be asked, and he will be expected to answer: did you attend the patient while living? what remedies did you prescribe? on what principles? did you examine the body after death? what were the appearances on dissection, in the brain, in the viscera of the thorax, in the intestinal canal? what reason have you to suppose that these were the appearances of poison exhibited? of what kind of poison? what are the characteristic appearances, if any, of each kind of poison? were there any actual appearances of poison in substance? did you collect any? what tests did you apply to discover the existence of poison? do you know the methods of detecting the various kinds of mineral poisons? what are they, and how did you apply them? Let us see you perform the experiment: this, in many cases, may be required; for though considerable and accurate knowledge of chemistry is necessary for the purpose, any of the poisons can be detected with very great approach to certainty by a small apparatus and in a short time; arsenic, for instance, either in Mr. Hume, Dr. Marcet's method by alkali and nitrate of silver, or in Scheele's method by copper, or in my own method by chromate of potash.

Chemistry is so useful, so extensively applicable,

so generally studied, and so generally understood, that the probabilities are greatly in favour of some judge on the bench, or juryman in the box, being competent to ask the necessary questions, and to judge of the propriety of the answers. I should be greatly grieved to witness a physician thus called upon in public before a jury of his country, unable to give the necessary information. But how is a man to give this information who is unacquainted with medical chemistry, in practice as well as in theory? Doubtless a physician who would confess ignorance, or exhibit ignorance on such an occasion, would meet with something like strong disapprobation from those who had a right to his professional testimony. Moreover, how often is it, that the healthiness or unhealthiness of particular trades and pursuits come into play, under the legal doctrine of *nuisance!* In all these cases, physicians are called in to give their testimony and their reasons for it. Almost all these legal discussions are chemical: and the questions asked relate for the most part to medical chemistry.

I deem it unnecessary to dilate on this subject; I quit it, therefore, and proceed to another branch of the present enquiry.

All *Remedies* for disease are drawn from the mineral, the vegetable, or the animal kingdom. Few from the latter. I would ask, is it possible for a physician to prescribe satisfactorily to himself or to his patient, who is unacquainted with the medicine he thinks fit to prescribe? Are not the great class of remedies drawn from the mineral kingdom? Are they not all chemical preparations, acting as chemical stimuli to the living fibre, and undergoing themselves chemical changes within the body—changes that vary with the condition of the body itself and its fluid contents? For instance, calomel very often lays for a long time absolutely inert in the body: sometimes it meets with phosphoric acid, and becomes a most drastic prepara-

tion. Sublimate to the amount of one-fourth of a grain is frequently given in alcoholic solution, but the eating of an egg may destroy its effect. The oxides of mercury will, in some instances where the action of the stomach is healthy, produce the effect intended in the usual doses: where acid is morbidly secreted in the stomach or intestines, the oxide is dissolved, and a drastic neutral salt is produced, whose operation cannot be counted upon, but will depend on the nature of the acid it meets with. Similar observations may be made on the preparations of silver, copper, tin, lead, antimony, bismuth, zinc, &c. whose numerous chemical metamorphoses form so conspicuous a page in the catalogue of materia medica. Can a physician who is not a chemist be qualified to prescribe these?

Nor is there less need of chemistry with respect to the *vegetable* materia medica. Are not the articles of this class, very few excepted, prepared either by decoction, infusion, inspissated extract, alcoholic resinous extract, tincture, or other chemical solution? Can any of these be satisfactorily prescribed without knowing the virtues of the preparation, as well as of the simple article? How many salts, extracts, infusions, and tinctures, simple and compound, have we of cinchona? It is dubious, indeed, whether any or all of them be equal to the bark in substance. Yet all these are necessary to be well understood before they can be judiciously prescribed. Can that man be a good workman who is not well acquainted with his tools? Can a physician safely tamper with chemical remedies, who is himself ignorant of chemistry? Again: all the medicines liable to be prescribed by a physician, are liable also to gross *adulterations:* for instance, calomel is frequently contaminated with sublimate or white lead: red precipitate with red lead: mercury with bismuth: magnesia with lime: ether with alcohol: the volatile oils with

turpentine: the mineral acids are generally compounds: carbonate of soda is found mixed with common and glauber's salt, &c. &c.

Surely it is desirable for a physician to be able to detect these mixtures, which he cannot do if he be not a chemist also.

I have said nothing of the medicinal exhibition of the gases, because when first introduced to public notice, they were expected, like all new nostrums, to perform every thing. Physicians found that it required too much trouble and too much skill to exhibit the gases; and they have been cried down. Now, that their pretensions are lowered to a reasonable standard, and that physicians now are expected to be chemists, they deserve a fuller trial than they have had yet. That hydrogen has prolonged life in confirmed pthisis—that oxygen has been of service in typhoid diseases—that nitrous oxide is well calculated so to be—are assertions not beyond the reasonable limits of medical probability. (See Professor Silliman's Journal of Science, No. I. p. 95.)

But this is not all: suppose a physician well grounded in the essential doctrines of life and disease, so far as they are dependent upon the properties of the living solid: suppose his medicines good, and the indications by which his prescriptions are to be guided, clear and unambiguous—I deny that he is fully competent to prescribe, unless he be also well versed in medical chemistry. Two remedies, each of them answering a manifest indication and proper for the disease, may destroy each other's efficacy when compounded. For instance, the sulphate of soda is a very common cathartic: prepared chalk, prescribed as an absorbent, acts also as a cathartic: when mixed together, they will form a compound perfectly inert as a medicine, and a deleterious load in the stomach. Aromatic vinegar is a good stimulus to the nerves, whether held to the nostrils or taken on a lump of su-

gar: so is volatile alkali: but the compound is the spirits of mindererus, a mild and weak diaphoretic. Sublimed oxide of zinc is a safe and mild tonic: so is oxide of bismuth: so is sulphuric acid; but the combinations of sulphuric acid with these substances rank among the poisonous emetics. Again: vinegar of squills is an efficacious expectorant; so is carbonate of ammonia: join them in a prescription, and the compound is an inert neutral salt, the acetate of ammonia. Sulphuric acid is a tonic, but the lead it usually contains is a poison.

In making the mineral solution for the ague, the dose may fail from the frequency of arsenic being adulterated with white calcareous spar. I have seen the effervescent mixture, prescribed and made in my presence at the apothecaries shop. I have seen the lixivium of hickory ashes preferred to salt of tartar. Nor is there a chemist who hears me, but must have known prescriptions rendered inert, by the composition of two or three medicines, each answering a common indication.

It is not possible for a physician to stir in his practice, without employing his knowledge of medical chemistry if he has it, or without lamenting the want of it, if he have it not. Hence it is, that not only the best chemists, but the best physicians of Europe, have been alive of late years to the improvement of medical chemistry; and to the prodigious importance of this branch of knowledge in medical practice. Where is the scientific journal devoted to medical pursuits, that does not overflow with chemical disquisitions connected with medical practice? Of living chemists in Sweden, Gahn and Berzelius: in Italy, Fontana, Scopoli, Brugnatelli, Morichini: in France, Parmentier, Deyeux, Gay-Lussac, Thenard, Vauquelin, Majendie, Margueron, and a crowd of others: in England, Davy, Bostock, Henry, Roget, Hatchett, Home, Wollaston, Marcet, Scudamore, Carlisle, and fifty others of the

medical profession, are engaged in it: every day increases the ardour with which this branch of science is pursued, and the votaries attached to its pursuit, because every day brings its vast importance more fully into view. Is this the favourable opportunity to decry the study of it here? to deny the necessary connexion of chemistry with medicine, and to regard it merely as an ornamental branch of medical education? Is this the time, when the obsolete arguments of twenty years back, are to be brought forward as the medical axioms of the present day? Doubtless such opinions are natural from gentlemen whose attention has not been alive to medical improvement, or whose limited information on this particular subject has not permitted them to keep up with it: but whatever strange and desultory opinions may have prevailed on this subject, in this city, one thing I take for granted, which we have all to be thankful for, that the medical school of Philadelphia has not yet ventured upon their adoption.*

A few words more on the method of teaching medical chemistry, and I have done.

The brilliant and imposing experiments usually devised to gratify the sight rather than inform the understanding, and to attract the ignorant and inexperienced, are misplaced here. A complicated and expensive apparatus is unnecessary, and therefore is misplaced here. After a few lectures in illustration of the general doctrines of chemical affinity, the experiments should be strictly confined to the subject matter; and brilliancy should be sacrificed to utility. I agree with that most able physician and chemist, Dr. Marcet (2 Med. and Chir. Trans. p. 358) that the large and dismal subterraneous laboratory of the old chemists, is now changed for the fire side of a comfortable study; and that under the auspices of Dr.

* Dr. Coxe, I know, agrees in opinion with me on the general subject of this discourse.

Wollaston and two or three more of the British chemists, the analysis of small quantities of matter with neatness and accuracy, promises to give an essential impulse to the progress of analytical chemistry. In fact, the apparatus for experiments in medical chemistry ought to occupy no more space than the drawer of a book case, and the required investigations may be prosecuted without injury to a mahogany table by the fire side.

It is a wise dispensation of Providence, that death should periodically remove the generations of the human race: were it not so, the progress of improvement would be stopt: for it is hard to convince ourselves as we advance in years, that the world of the present day can be much wiser than the world of our youth; and those who have neglected to keep pace with the progress of knowledge, never will be convinced of it.

I hope, however, that on this subject I have been able to produce facts and arguments of sufficient cogency, to shew, that whatever might have been the state of medical chemistry when my cotemporaries were young, it holds a present rank among the branches of useful science with claims far superior, and too imperious to be slighted: and that I do not express myself too strongly when I say, that it is a branch of science INDISPENSIBLE to medicine.

THE END.